COMMUNITY AND PERSONAL EXPOSURES TO AIRBORNE CONTAMINANTS IN AN URBAN-INDUSTRIAL HOT SPOT

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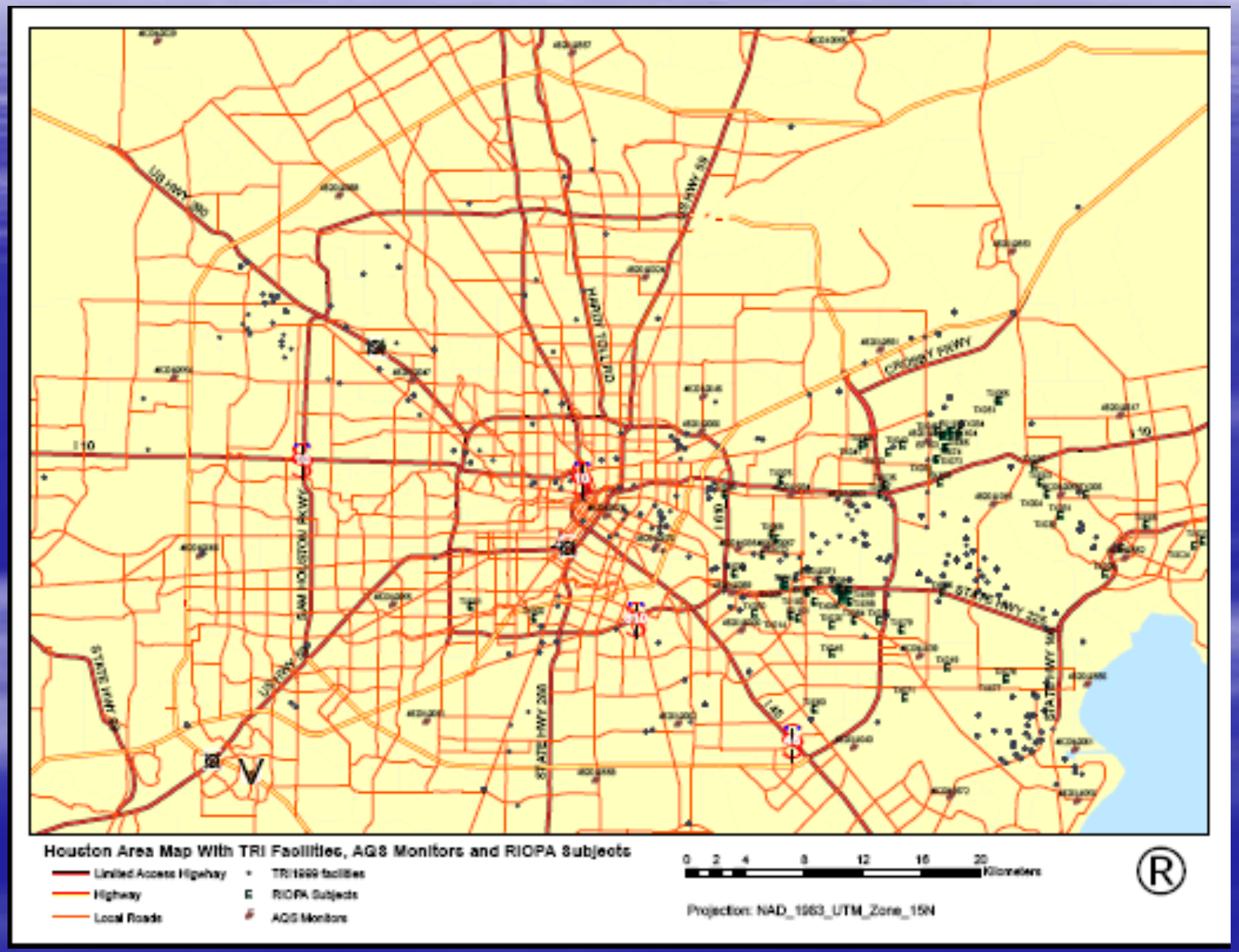
Topics:

- Describe the complexity of the urban-industrial conurbation in Houston, TX
- Present data on residential indoor, outdoor, and personal exposures to air pollutants in this urban-industrial complex (RIOPA Study).
- Show that fixed-site ambient concentrations of air pollutants can underestimate community-level concentrations and exposures.

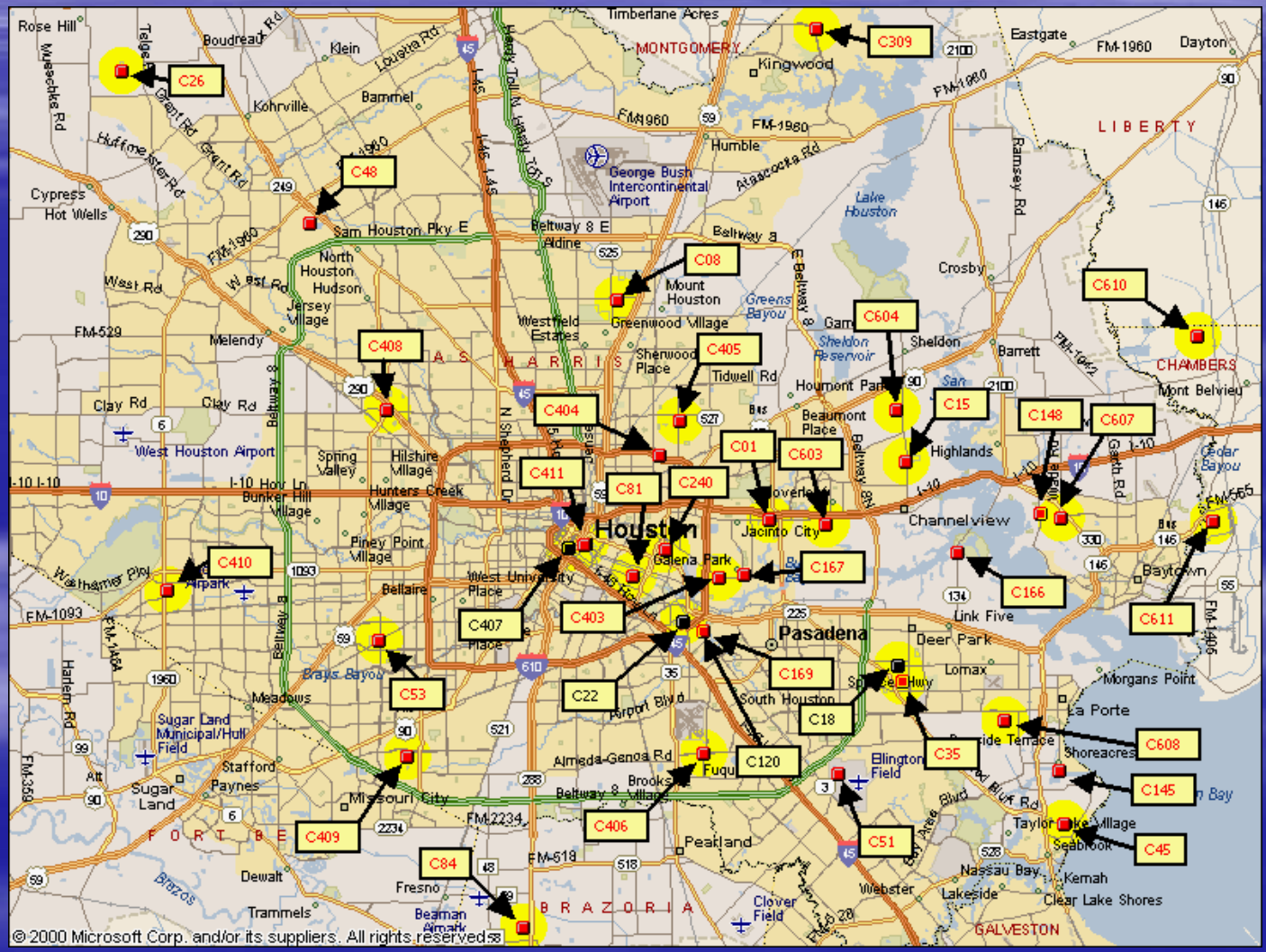
Background

- The Texas Upper Golf Coast is home to the largest concentration of petrochemical facilities in the nation.
- These facilities are currently located very close to or within urban areas because of urban growth.
- Several of the urban and near-urban areas have extensive ambient monitoring networks which show elevated ambient levels of several air toxics compared to other cities.
- The Houston Metropolitan Area (fourth largest in the US) has some of the largest TRI emission facilities in the country together with an extensive network of roads, rail, and waterway transport systems that serve those industries.
- These characteristics suggest that the population in this area may be at increased risk from exposures to industrial and other source emissions.
- In contrast to the potential exposure and health risks, relatively little is known about community/personal exposures to airborne contaminants or their potential impact on health in the Houston Metropolitan area.

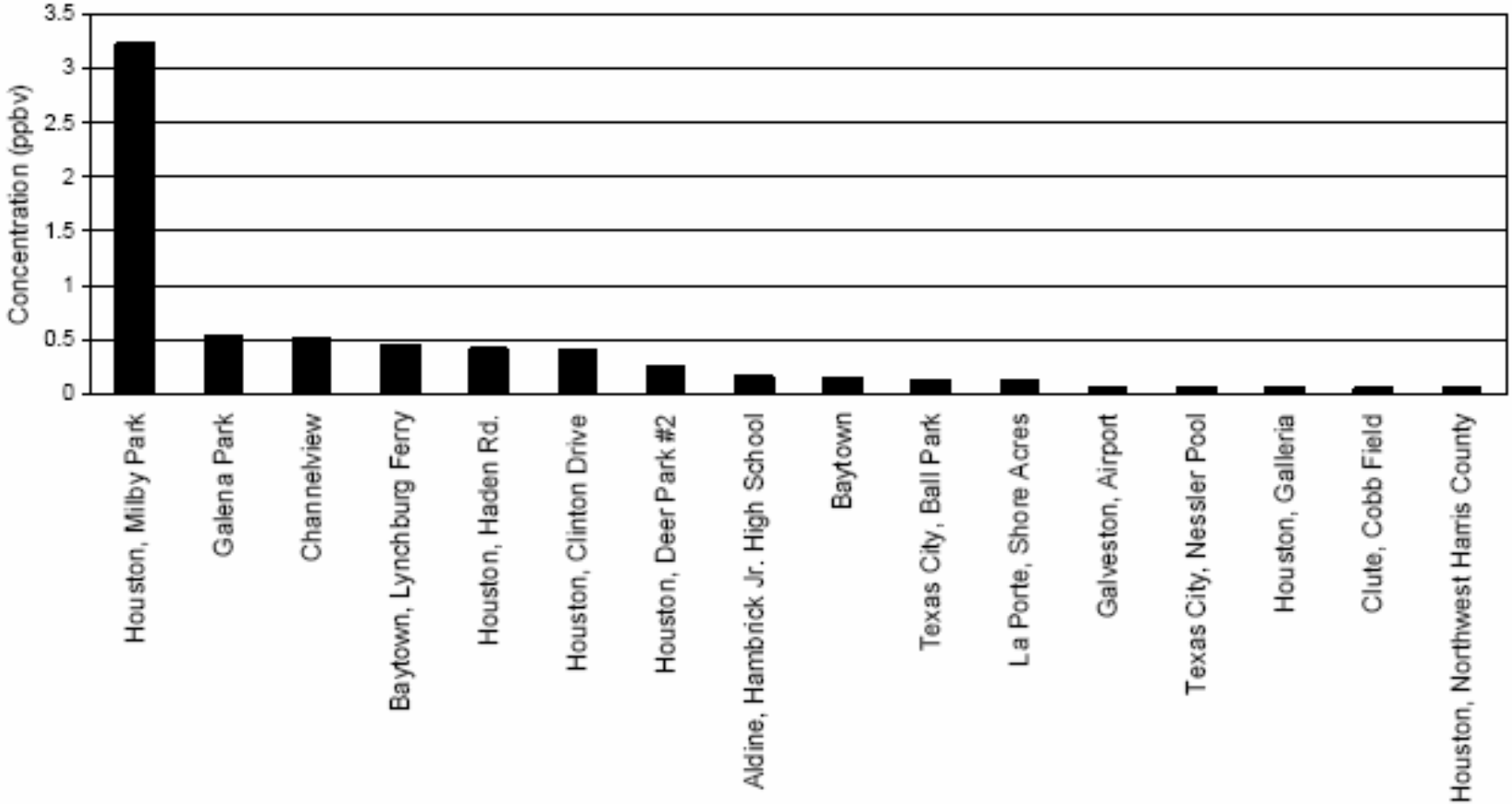
Houston - TRI Facilities



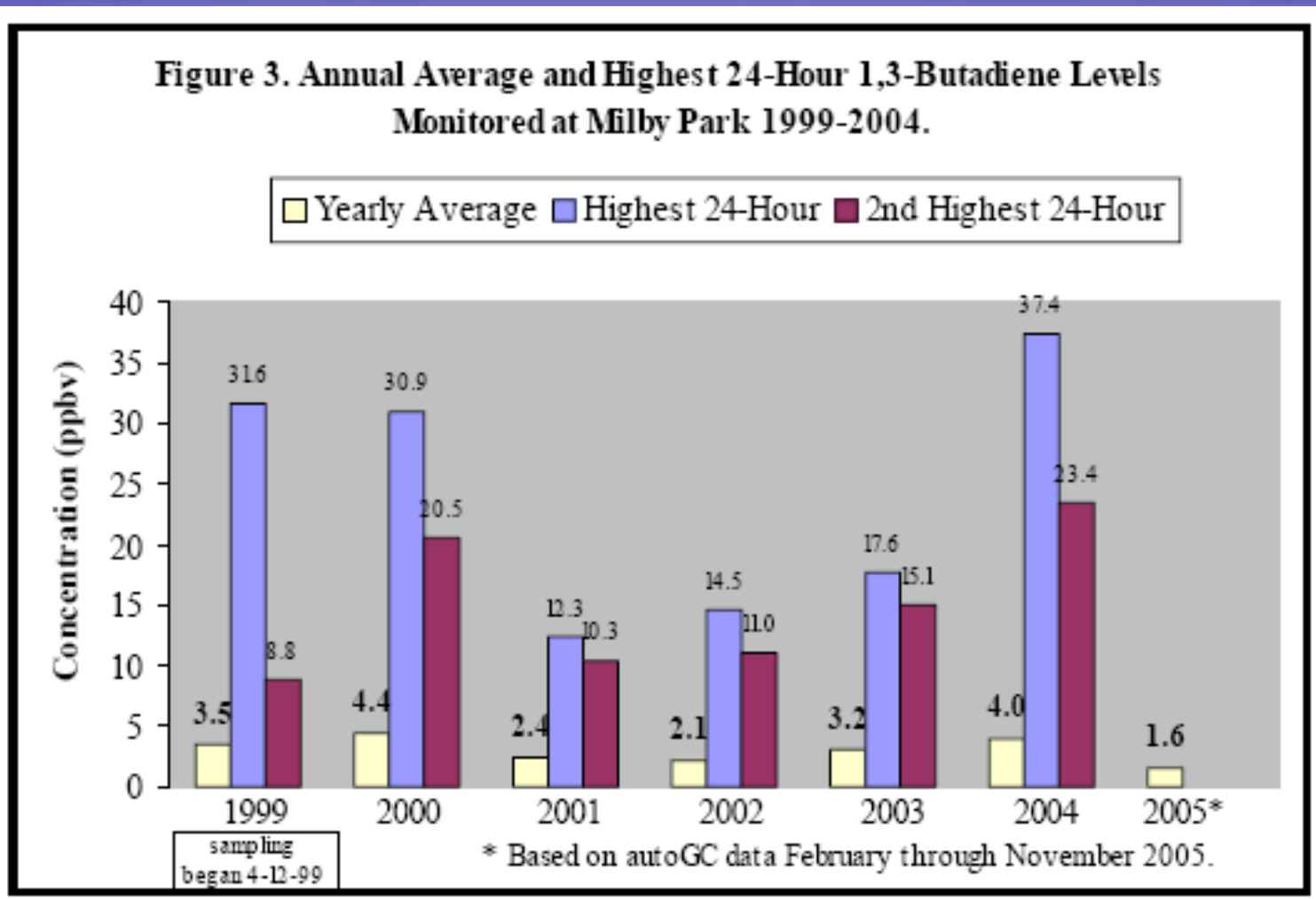
Harris County- Houston Ambient Monitoring Sites



Annual Average Ambient Butadiene Concentrations - 2003



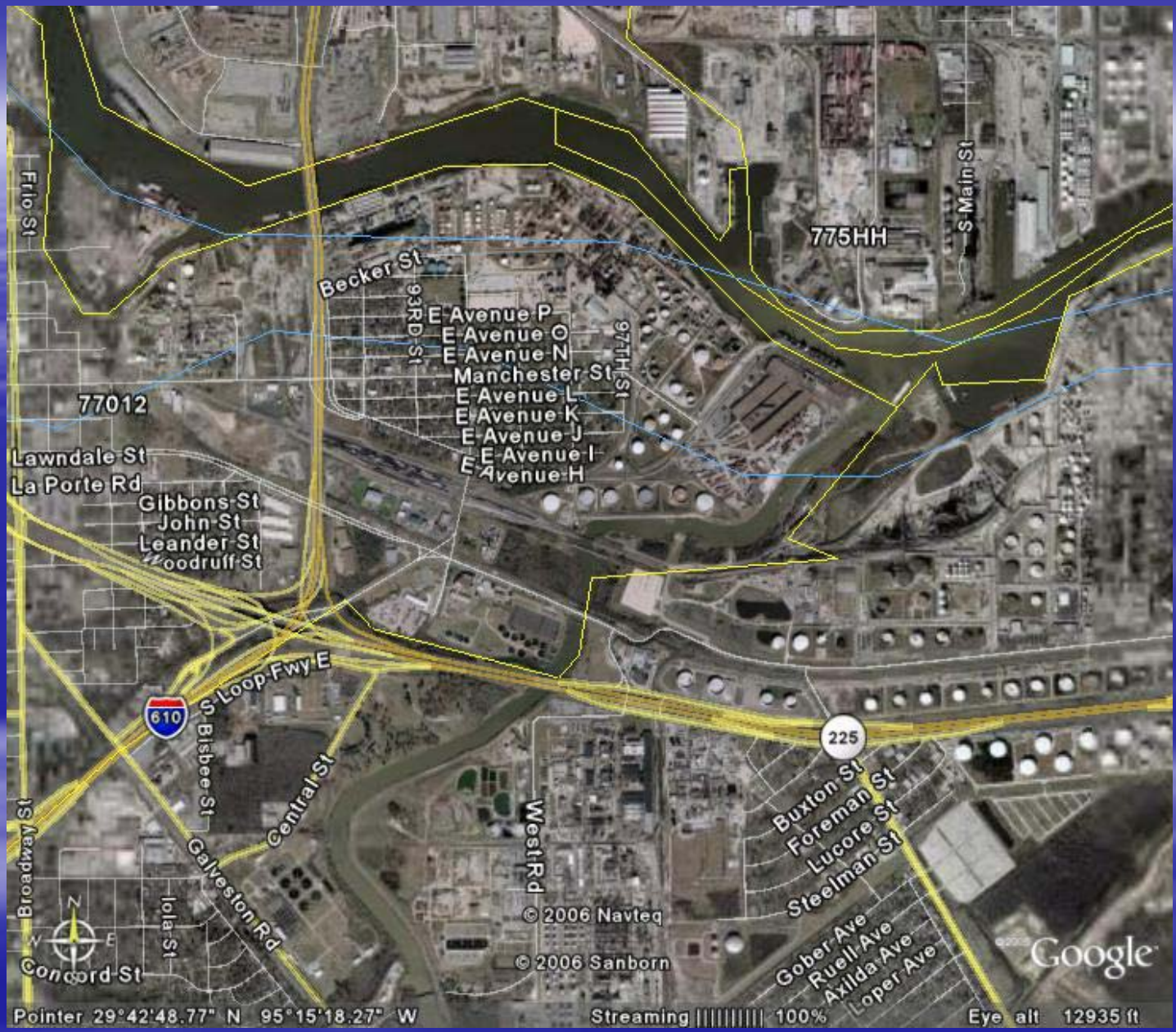
Source: TCEQ Interoffice Memorandum, 01/03/05



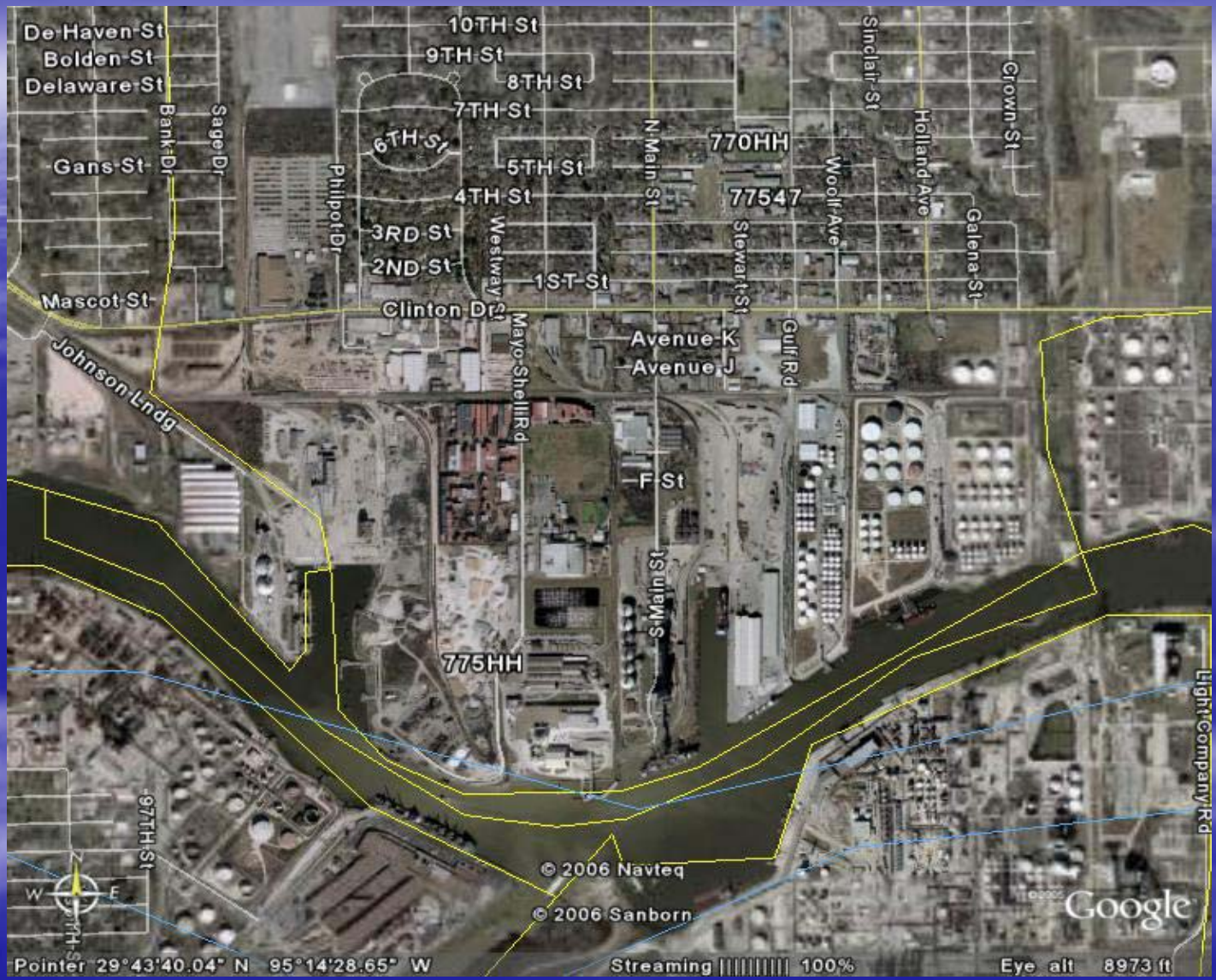
Source: TCEQ Draft Interoffice Memorandum, 2006

Milby Park Monitoring Site

Source: TCEQ Interoffice Memorandum, 01/03/05



Manchester area



Clinton Drive

RIOPA Study Design:

Purpose: Determine the contribution of outdoor air to indoor concentrations and personal exposures to selected airborne pollutants (1998-2001).

Sample: 100 non-smoking homes in each of three urban centers: Elizabeth, NJ; Houston, TX; Los Angeles, CA, near and away from sources (near ≤ 0.5 km from source; 75% of households)

Target pollutants: VOCs, PAHs, PM2.5 (elements/functional groups), carbonyls, EC/OC

Measurements: 48-hour samples: personal (adult and children), residential indoor & outdoor air.

In-vehicle during driving (carbonyls).

Residential AER and I/O temperature.

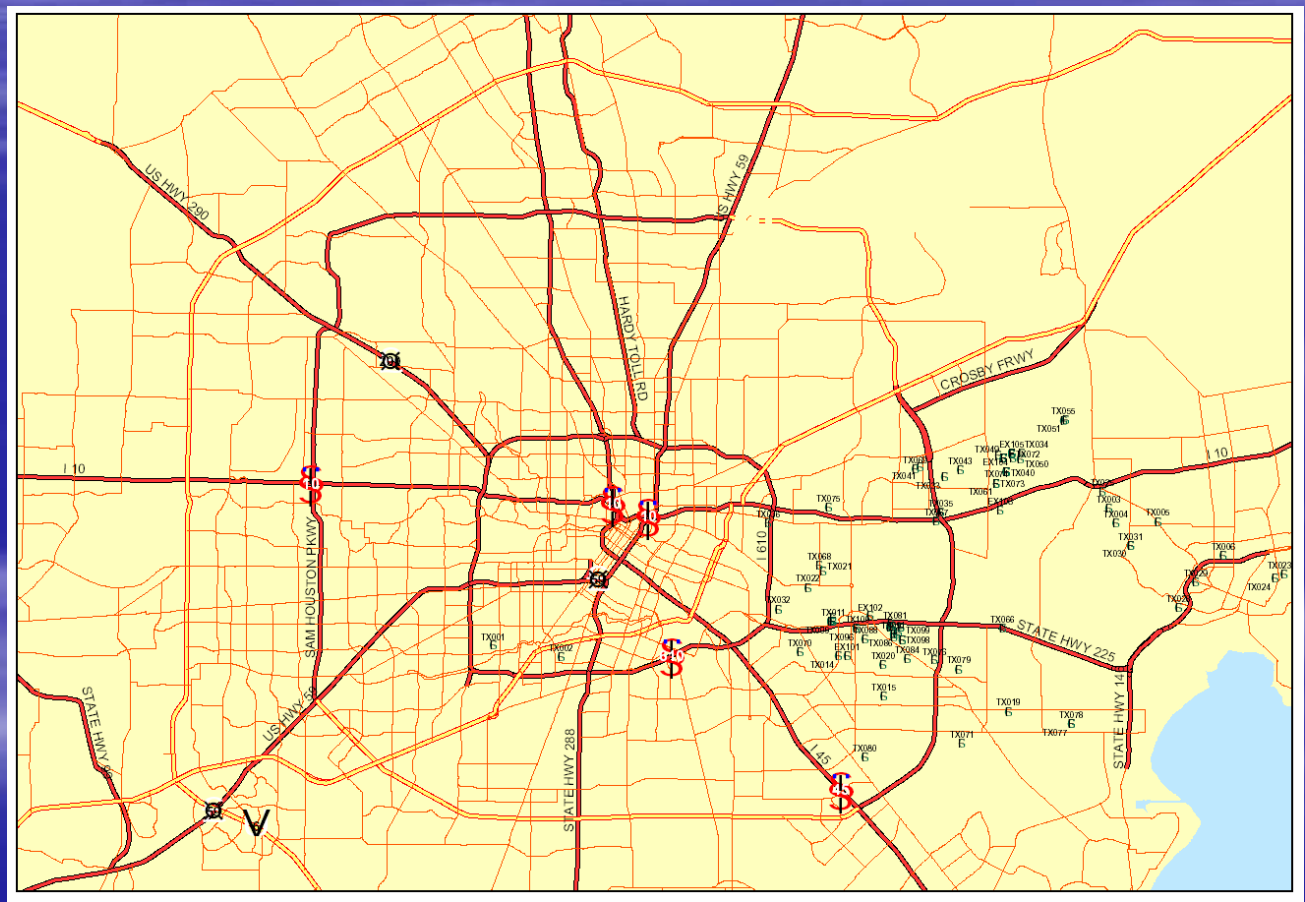
Questionnaires (e.g., time-location patterns)

1998-2001

City Selection Criteria

- NJ - mixture of point, area, and mobile sources
- TX - predominantly industrial (point)
- CA -predominantly (mobile)
- Differences in meteorology and housing characteristics across the three cities: Elizabeth, Houston, and Los Angeles

RIOPA-TEXAS Sampling Locations



RIOPA In-Vehicle Carbonyl Monitoring

Figure 2. In-vehicle sampling setup as it was placed during sampling.

RIOPA-TEXAS – Personal Time-Location Patterns (% time)

Mean

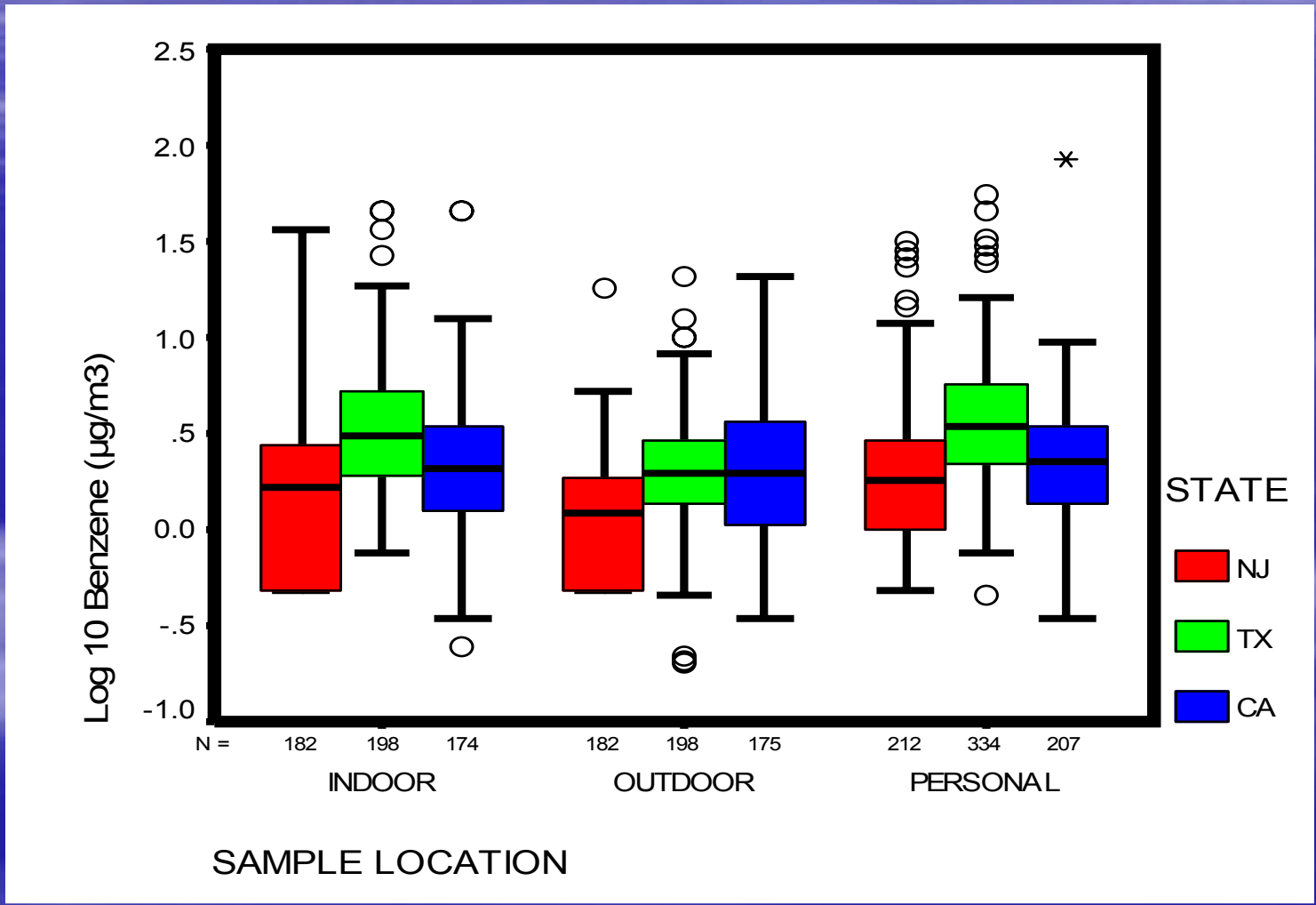
	ADULTS	CHILDREN
HOME	81.80	65.71
SCHOOL	1.83	18.46
INDOOR OTHER	5.04	3.49
OUTDOOR-NEIGHBORHOOD	3.11	3.93
OUTDOOR AWAY	.77	.32
CAR-WINDOWS OPENED	1.10	.95
CAR-WINDOWS CLOSED	2.96	1.60
TOTAL INDOORS	91.73	92.76
TOTAL OUTDOORS	3.99	4.52
TOTAL IN CAR	4.28	2.72

RIOPA Air Exchange Rates

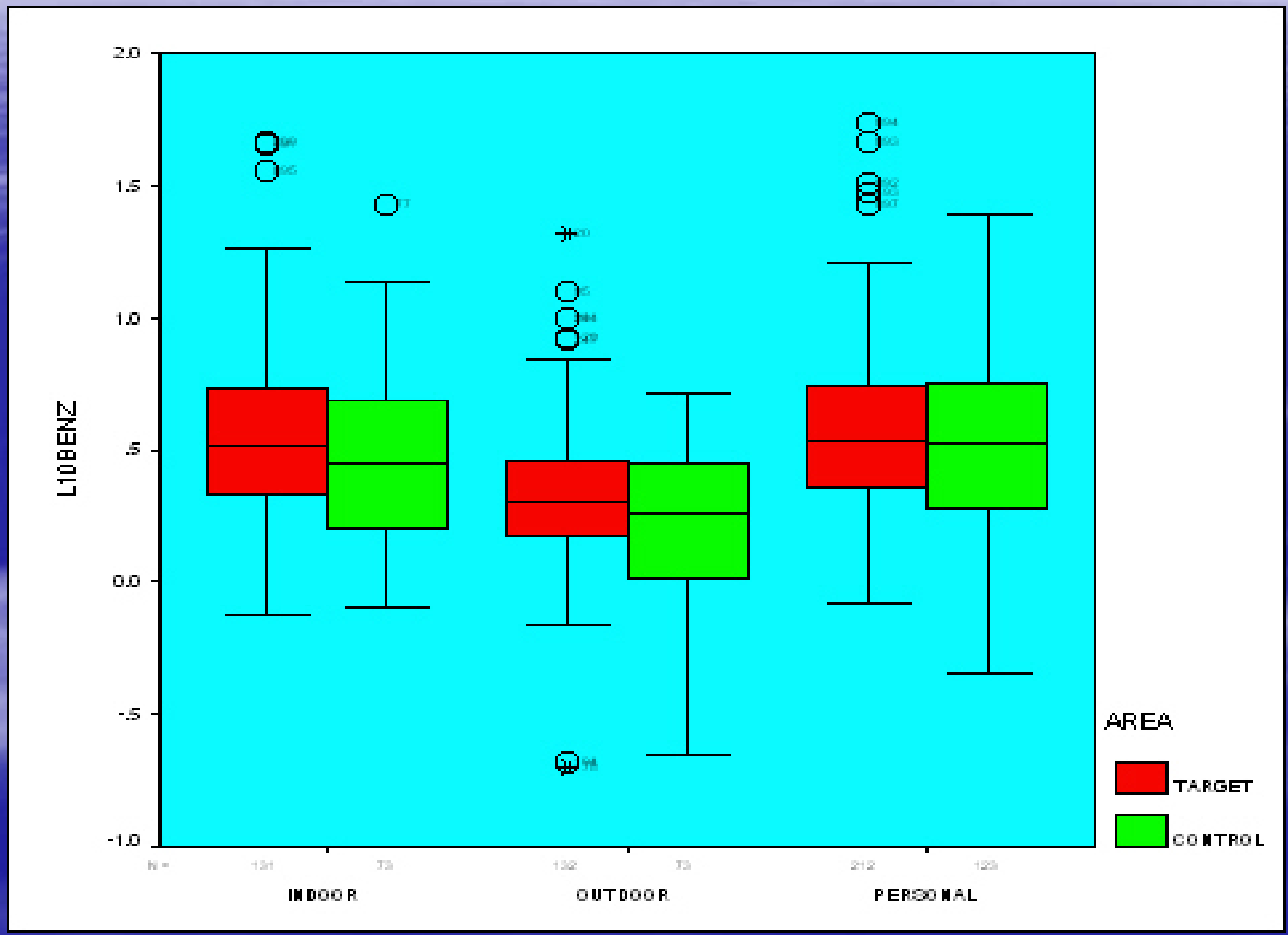
AIR EXCHANGE RATE (1/hr)

	Mean	Median	STD	G. Mean	N
NJ	1.4269	.8800	1.4212	1.0019	177
TX	1.4065	.4800	6.4256	.5387	217
CA	1.3728	.8700	2.0800	.8977	211
Total	1.4007	.7200	4.1059	.7719	605

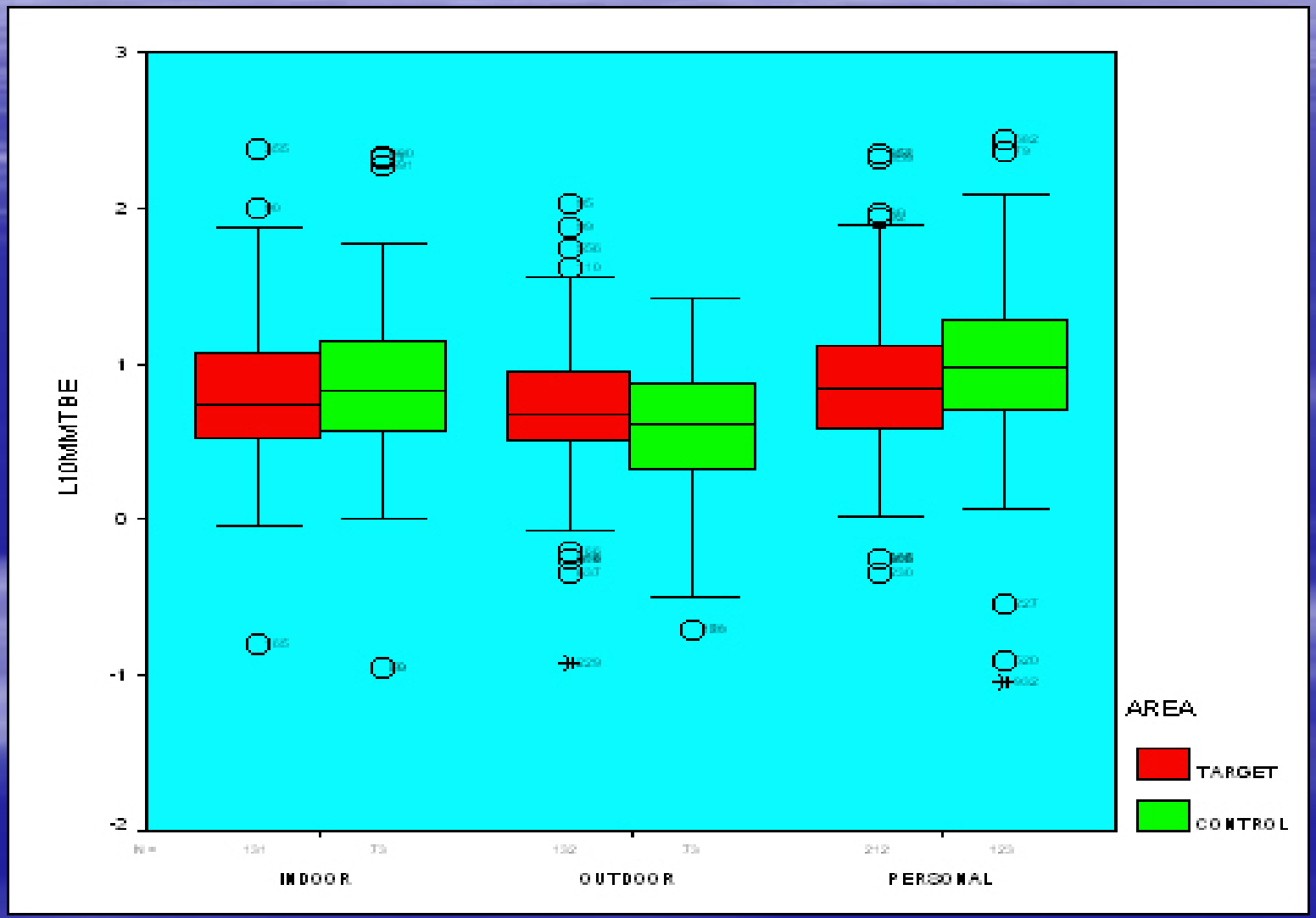
RIOPA Benzene



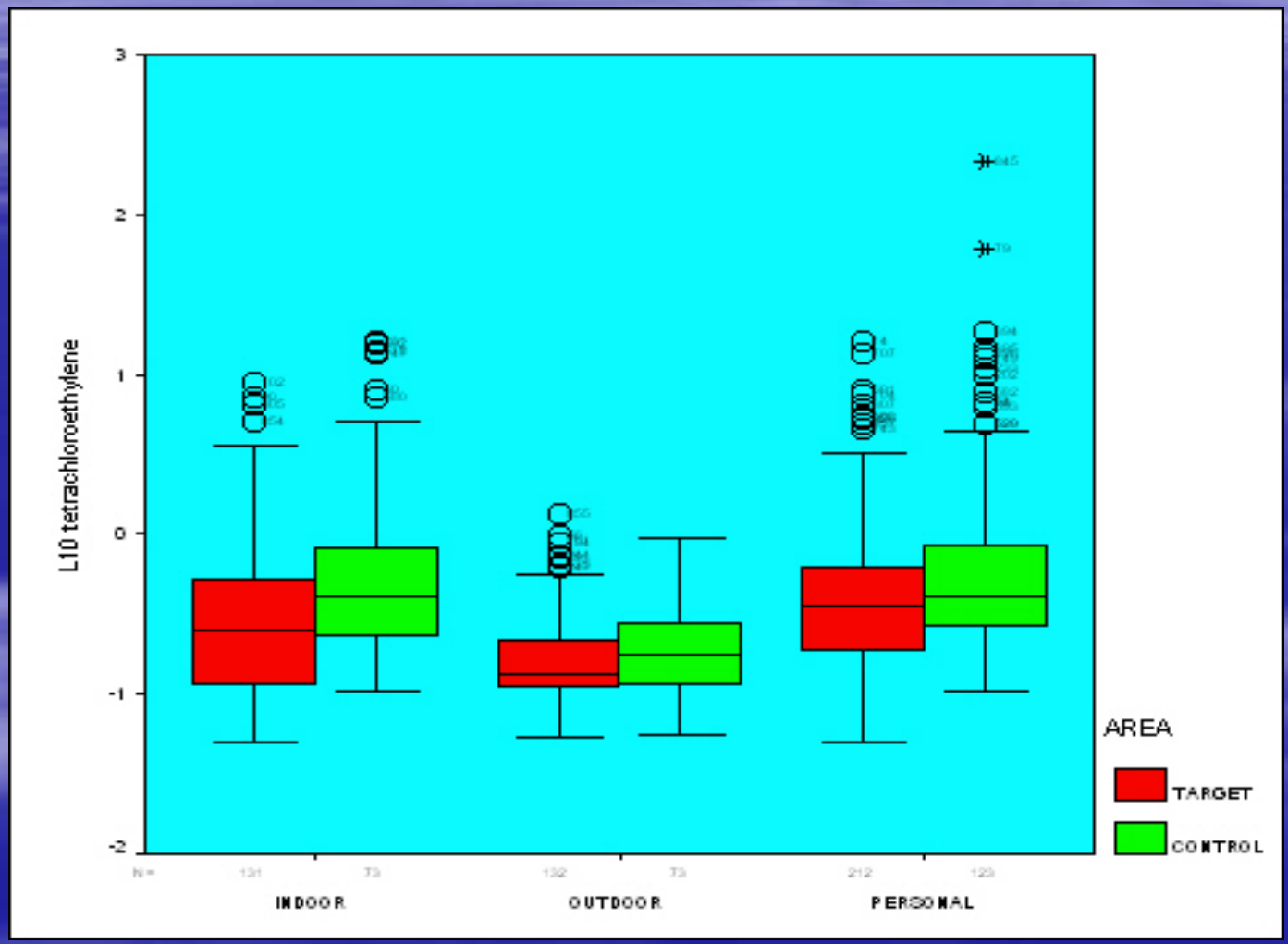
RIOPA-TEXAS Benzene by Area



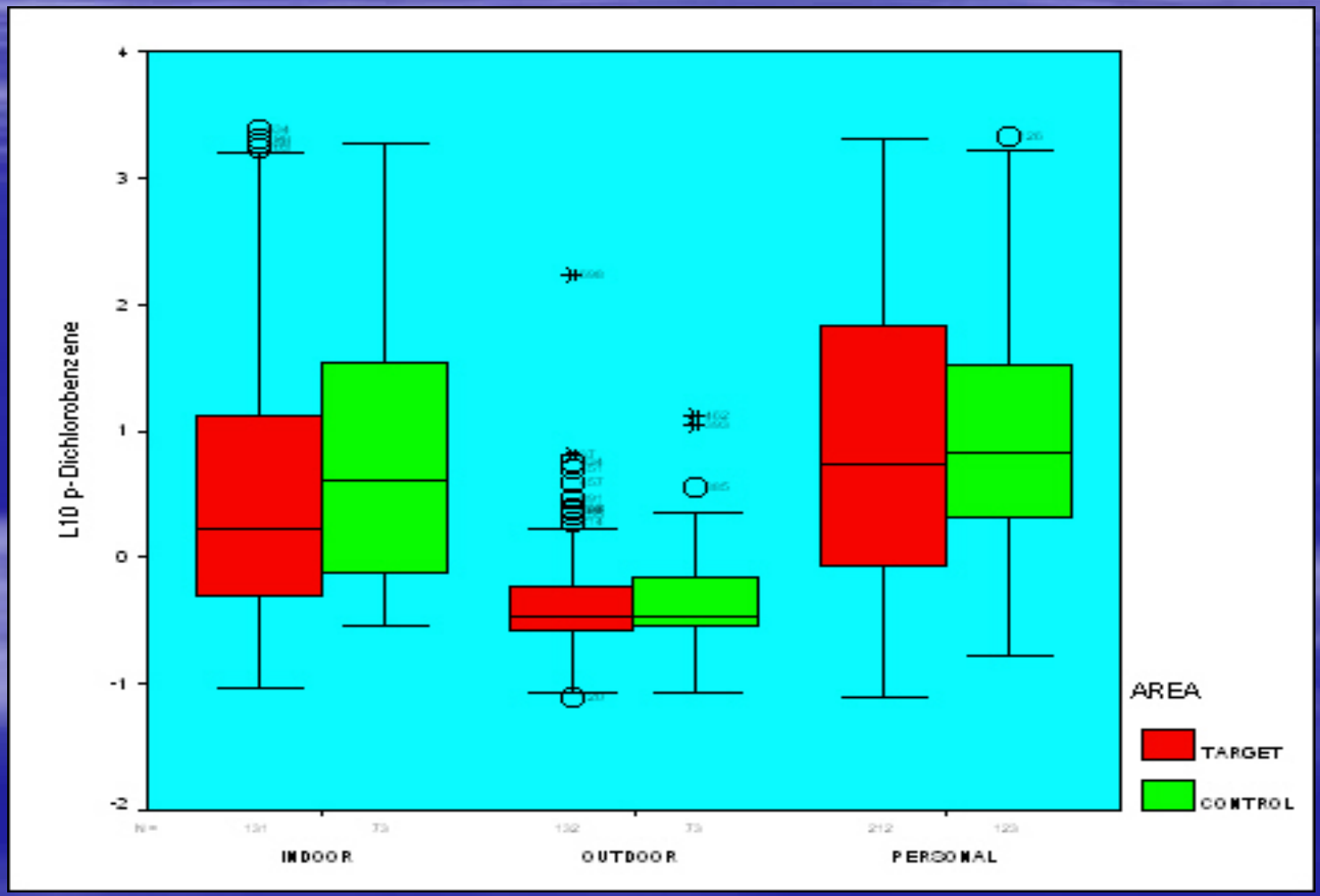
RIOPA TEXAS – MTBE by Area



RIOPA TEXAS – PERC by Area



RIOPA TX p-Dichlorobenzene

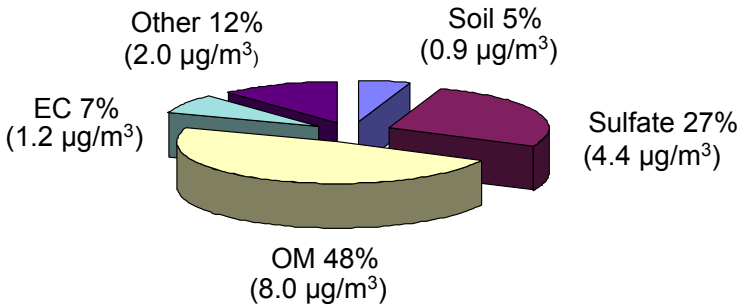


RIOPA – PM2.5 INDOOR/OUTDOOR RELATIONSHIPS (by AER)

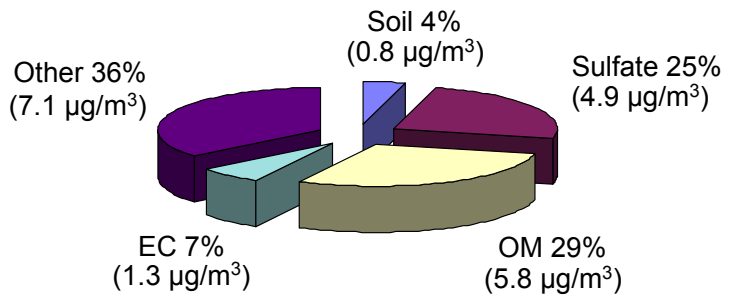
	AIR EXHANGE RATE	REGRESSION COEFF	P-VALUE (r.c.)	INTERCEPT	P-VALUE (INT.)	R** 2	N
	0.0 - 0.5	.18	.14	10.50	.04	.03	69
	0.5 - 1.0	.54	.00	7.82	.00	.28	98
	1.0 - 2.0	.55	.00	10.48	.00	.30	62
	2.0 - 4.0	.46	.09	6.81	.12	.21	30
	4.0 - 8.0	.66	.01	5.32	.22	.43	14
	>1.00	.51	.00	9.96	.00	.25	106
	0.00-8.00	.43	.00	8.77	.00	.51	253

RIOPA – TEXAS $PM_{2.5}$

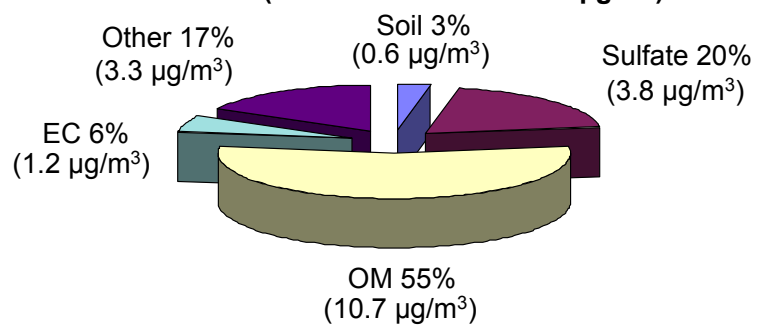
CA indoor (ave. mass conc. = 16.6 µg/m³)



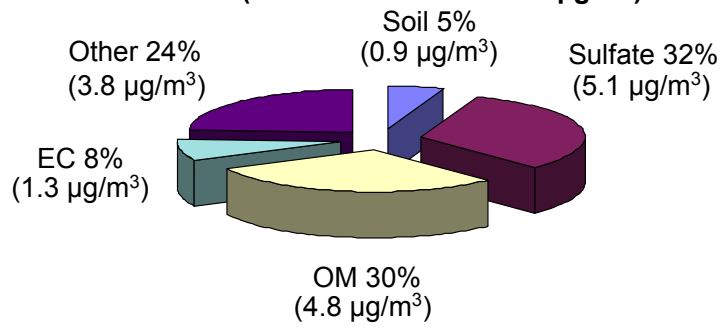
CA outdoor (ave. mass conc. = 19.8 µg/m³)



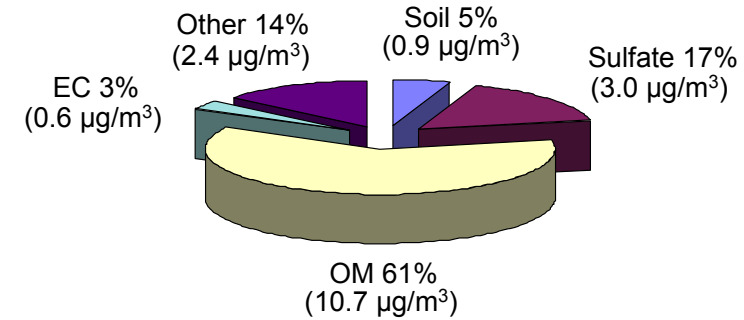
NJ indoor (ave. mass conc. = 19.7 µg/m³)



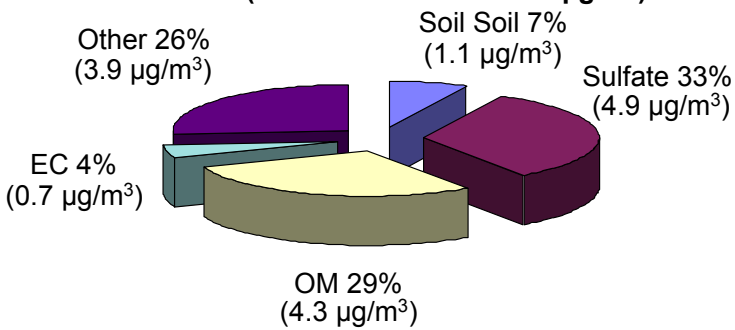
NJ outdoor (ave. mass conc. = 15.8 µg/m³)



TX indoor (ave. mass conc. = 17.7 µg/m³)



TX outdoor (ave. mass conc. = 14.9 µg/m³)



Polidori et al; under review (125 homes)

RIOPA-TEXAS $PM_{2.5}$

AREA		OUTDOOR	INDOOR	PERSONAL	AER 1/hr
CASE	Mean	14.27	17.99	37.89	.99
	Median	13.03	14.40	30.84	.52
	N	59	59	59	59
CONTROL	Mean	16.09	10.13	29.25	.48
	Median	15.32	7.74	29.95	.30
	N	18	18	18	18
Total	Mean	14.69	16.15	35.87	.87
	Median	13.27	13.40	30.84	.47
	N	77	77	77	77

Summary

- The urban-industrial “hot spot” includes both industrial and mobile sources.
- Fixed-site ambient monitoring concentrations can underestimate not only personal exposures but also outdoor residential concentrations.
- Residential characteristics (e.g., AER), lifestyle choices, and household activities are very important modifiers of exposure-ambient concentration relationships.